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Accuracy of straight leg raise and slump tests in detecting lumbar disc herniation: a pilot study

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Abstract

Objective: To determine the accuracy of the Straight Leg Raise (SLR) and slump tests in detecting Lumbar

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Disc Herniation (LDH).

Design: Cross-sectional diagnostic accuracy study.

Setting: Two referral hospitals in Kigali, Rwanda: King Faisal Hospital and Centre Hospitalier Universitaire de Kigali.

Subjects: All patients aged 18 to 70 who had an MRI and who were experiencing pain in the low back, leg or low back and leg.

Interventions: Closed Magnetic Resonance Imaging (MRI) investigations for each patient as witnessed by a radiologist who read the image were recorded by the first researcher and blinded to other researchers. The SLR and slump tests were performed three times on each patient by independent testers who were blinded to the result of the first test. The test order was randomized for each subject and the two tests were separated by one day wash-out period.

Main Outcome Measures: Data were analyzed using a 2x2 table to ascertain diagnostic statistics including sensitivity and specificity with 95% confidence intervals.

Results: Thirty three from a possible 37 patients mean age 41.58 ± 10 years completed all of the tests. The sensitivity of SLR was greater (0.875; CI: 0.690-0.957) than that of the slump tests (0.800; CI: 0.6087-0.911) ($p=0.01$) in detecting LDH. The specificity for SLR was 0.429 (CI: 0.158-0.750) and for slump was 0.714 (CI: 0.359-0.918). Substantial agreement ($K=0.774$) was obtained between the SLR and MRI.

Conclusion: The SLR was more accurate in detecting LDH. Further validation of this pilot finding is required by studying a larger sample.

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Introduction

Low back pain (LBP) is the most common musculoskeletal condition, with a lifetime prevalence of 84% in the general adult population.¹ One often diagnosed cause is a herniated inter-vertebral disc exerting pressure on the nerve root.² This is clinically termed lumbar disc herniation (LDH). In LDH, physical examination findings, reported symptoms, and findings on the imaging technique do not always correlate.⁴

The straight leg raise (SLR) and slump tests are the main physical examination tests commonly used to access LDH.⁵ Definitive determination of the presence of LDH is typically reliant on the use of Magnetic Resonance Imaging (MRI). MRI is capable of detecting lumbar spine derangements including bulging, protrusions or herniated discs and any associated nerve root compression.⁵ MRI provides accurate information on the structure of the spinal column⁸ and is said to be the gold standard in detecting LDH.^{9,10} As a principle, radiographic modalities are preferred for diagnosis when their benefits exceeds side effects.¹¹ This recommendation by Chou and colleagues is contrary to what often prevails in the clinical setting where patients with any type of LBP are routinely exposed to radiographic diagnostic machines and MRI even if the clinical signs and symptoms clearly point to a specific condition. Furthermore, these imaging processes are costly and take more time to arrange and execute, which may contribute to prolonged and severe pain especially in patients with acute LDH.

Majlesi *et al* report that the slump is more sensitive than the SLR test,⁴ whereas the SLR test is said to be more sensitive than the slump test.^{2,6} The high sensitivity (0.91) of the SLR suggests that, given a

negative test result, the diagnosis of acute LDH may be ruled out with reasonable confidence.¹² However, Willick *et al*¹³ report that the slump test might be preferred over the better known SLR¹³ because the slumped trunk can be added to the hip flexion to exert further tension when necessary. Nonetheless, the literature continues to yield contradictory reports regarding the more accurate test of the two in detecting LDH.

Magnetic Resonance Imaging is not widely available in Rwanda and in many developing countries, and where it is costs are prohibitive. In Rwanda the cost of one lumbar MRI is in excess of US\$385.00.

The primary objective of this pilot study was to determine the accuracy of the SLR and slump tests in detecting LDH. Secondly, we sought to determine the agreement between these two tests and the results obtained from an MRI in detecting LDH. We hypothesized that the SLR is as sensitive as the slump test in detecting LDH.

Method

This study was approved by the institutional review boards of Kigali Health Institute (KHI), Centre Hospitalier Universitaire de Kigali (CHUK), and King Faisal Hospital (KFH) 26/RBC/KHI/2011.

The study was conducted at KFH and CHUK. King Faisal is a semi-autonomous hospital with 181 beds; whereas, CHUK is a state owned hospital with 560 beds. Most patients with LDH are referred to either KFH or CHUK for care including physiotherapy, but KFH is the only hospital in Rwanda with MRI facilities and receives all patients requiring MRI who can pay, including patients from Burundi and the Democratic Republic of Congo (DRC).

A hospital-based sample of all patients was recruited

for study over a six-week period from the Radiology and Physiotherapy Departments of KFH and CHUK. Patients were selected on satisfying the following inclusion criteria:

- 1) pain in the low back, leg or low back and leg.
- 2) a low back MRI report from the radiologist, and
- 3) aged 18-70 years.

Subjects were excluded if they had:

- 1) signs of serious lumbar pathology (infection, cauda equine lesions, spinal instability) to avoid aggravation of the condition;
- 2) pregnancy, to avoid increased venous return from the inferior vena cava which is compressed by the enlarged uterus;
- 3) spinal surgery done within the eight weeks immediately preceding the study;
- 4) were unable to communicate verbally;
- 5) cervical dysfunction and hip and knee pathology. The study purpose and procedures were explained to each patient and informed consent was sought and obtained.

A cross-sectional diagnostic accuracy study design was employed. The study was conducted in accordance with the Standards for Reporting of Studies of Diagnostic Accuracy (STARD).¹⁴ The following data elements were recorded for each subject: demographic information, current and past history from records, results of MRI investigations, and performance on the slump and SLR tests as described below.

A pre-pilot study was conducted on eight patients, to test procedures and determine applicability of the checklist on patients with LDH.

Further modification of the checklist was necessary to 'clean' the test procedures as follows:

- 1) assessment of pain intensity in part 3 (current history) of the checklist was moved to part 5 (test performance).
- 2) assessment of pain was performed for both sides and a pain rating attributed separately for the right and left sides.

Patients were assigned to one researcher (EN) who determined eligibility for selection, and obtained the medical history. The SLR and slump test were performed in random order.

The SLR test was performed while the patient was supine, with the hip flexed and the knee straight. The tester passively flexed the hip thereby stretching the sciatic nerve. A positive test was defined as one that reproduced pain the low back radiating down in to the posterior thigh and or legs (See plate 1).

Plate: Performance of the straight leg raise test.



The slump test was performed while the patient maintained a slumped sitting posture while the tester passively extended the knee. A positive test was defined as one that reproduced pain in the low back and or radiating down into the posterior thigh and legs (see plate 2). If no pain was reported, passive ankle dorsiflexion was added to the test procedure. If a patient then reported pain in this case, the test was defined as positive.

Plate II: Performance of the slump test.



Patients allocated to be examined using the SLR first were sent to Tester 1 (JH- performed all the SLR tests), while those allocated to begin with the slump test were sent to Tester 2 (JTN performed all the slump tests). Both testers were blinded to results of the history obtained by the 1st researcher. Both the SLR and slump tests were repeated three times and recorded. The pain intensity and joint range of motion (hip flexion SLR, and knee flexion slump) at which the two procedures tested positive were also recorded. Patients were requested to return for the second test (the one not done

on the first day) on the next day to minimize neural sensitization that can cause the test to be negative. The same procedures were performed in the same way and by the same testers. Both the SLR and slump tests were applied on the right and lefts legs, starting with the reported asymptomatic side.

Finally, the patients received physiotherapy treatment and back care advice from the researchers to satisfy ethical requirements.

The fourth researcher (JM), who was blinded to all previous protocols entered and analyzed the pre-coded data. All data were analyzed using SPSS version 14.0. Descriptive statistics were used to characterize the sample's demographic data and data related to the LDH and physical examination findings. Based on Viera *et al*,¹⁶ the Kappa coefficient (K) was calculated to compare the agreement between results from the reference standard MRI and both index tests (SLR and slump). Positive and negative results from MRI were cross tabulated (2*2 table) with positive and negative results from each index test.

A confidence interval calculator from Michaleff *et al*, was used to determine the sensitivity, specificity, Positive Predictive Value (PPV), Negative Predictive Value (NPV), Negative Likelihood Ratio (NLR) and Positive Likelihood Ratio (PLR) for both tests at the 95% confidence level. The accurate test was determined as the one reflecting results more similar to those of the MRI.

The limitations of this study were the small sample size due to use of patients with existing MRI. The high cost of MRI made it improbable to request more of these investigations under the study budget. Subsequently, some selection bias was inevitable; hence the authors suggest that the results of this study be viewed in the context of a pilot study.

Table II: Accuracy parameters for the SLR and the slump tests (95% confidence level).

	Sensitivity	PPV	PLR	Specificity	NPV	NLR
SLR	0.875 (CI: 0.690-0.957)	0.840 (CI: 0.631-0.948)	1.531 (CI: 0.792-2.960)	0.429 (CI: 0.158-0.750)	0.500 (CI: 0.140-0.861)	0.292 (CI: 0.075-1.137)
Slump	0.800 (CI: 0.609-0.911)	0.909 (CI: 0.694-0.984)	2.800 (CI: 0.854-9.182)	0.714 (CI: 0.359-0.918)	0.500 (CI: 0.201-0.799)	0.280 (CI: 1.48-67.554)

A flow diagram (see figure I) adopted from STARD¹⁵ shows the test results obtained when the SLR and

Results

There were 37 patients available for the study in CHUK (12) and KFH (25). One patient refused to participate in the study and 3 were excluded (one had an abdominal hernia, the second had spinal spondylosis, and the third had pain in the hip joint). Three patients did not return for the second test. The final sample was 33 patients; 19 (57.6%) were women while 14 (42.4%) were men. The mean age was 41.6 ± 10.4 years. Most lumbar spine disc herniations were at L4-5 (15.2%) and L5-S1 (36.4%). The severity of the disc herniations ranged from bulge represented by 27.3%, bulge and nerve root compression 30.3% in the 33 patients who were tested. The right side was affected 42.9% of the time and left 49.2% of the time.

The SLR and slump tested positive on 19 (63.3%) patients and both tested negative on 4 patients. 2 patients were positive on the slump test only while 5 patients were positive on the SLR test only. All test results are elaborated in table I.

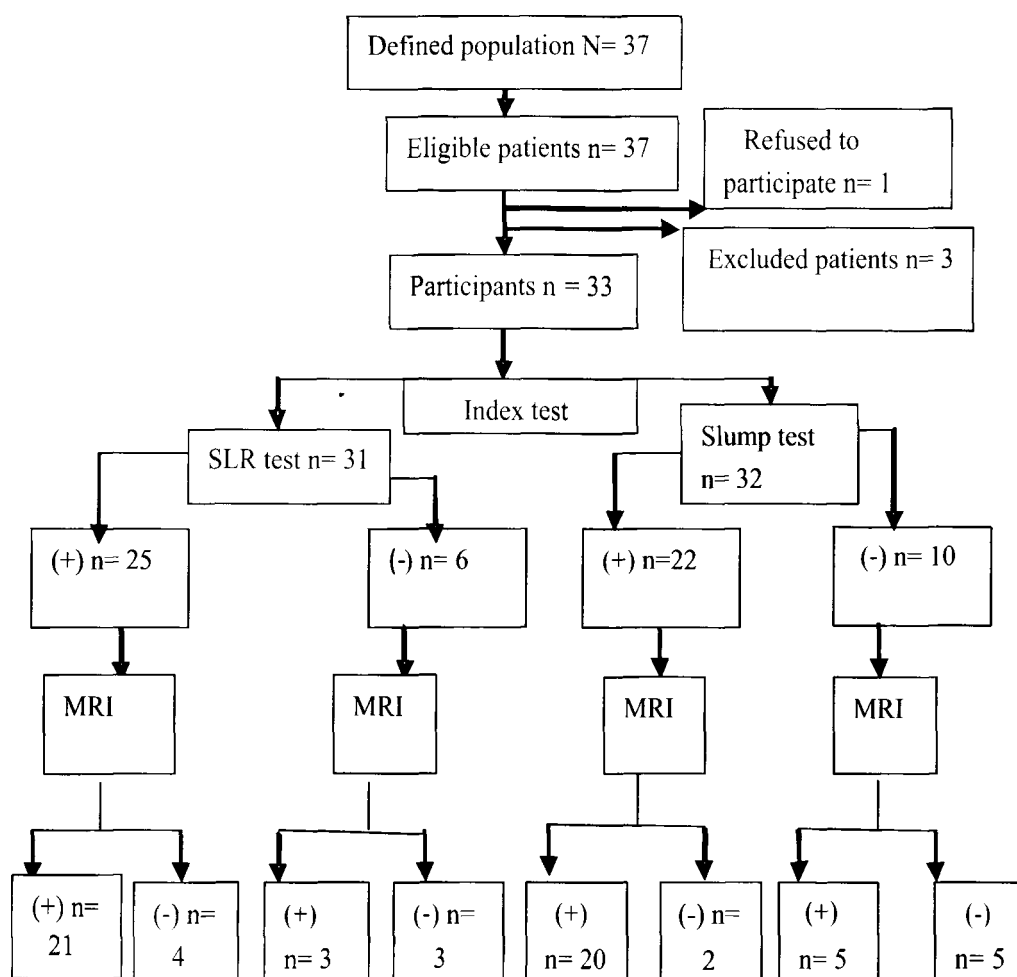
Table I: Agreement of SLR and slump tests (chi-square: 4.80; Yates correction: 2.87).

	SLR(+)	SLR (-)	Total
Slump (+)	19	2	21
Slump (-)	5	4	9
Total	24	6	30

Sensitivity, specificity, PPV, NPV and PLR of both the SLR and slump tests are shown in table II.

slump test are compared to the MRI investigation result.

Figure 1: Flow chart showing results of the SLR, slump test and MRI.



The kappa coefficient $K=0.774$ was obtained showing substantial agreement between the results of the MRI and SLR (see table III). While $K=0.446$ was obtained showing moderate agreement between the results of the MRI and the results of the slump test (see table IV). The calculated chi-square = 4.8015873 was greater than the observed chi-square = 3.4146. Therefore, the null hypothesis (SLR test is sensitive as slump test) was rejected.

Table III: Agreement of the SLR and MRI (chi-square: 3.20; Yates correction: 1.55).

	MRI (+)	MRI (-)	Total
SLR (+)	21	4	25
SLR (-)	3	3	6
Total	24	7	31

Table IV: Agreement of the slump test and MRI (chi-square: 6.73; Yates correction: 4.55).

	MRI (+)	MRI (-)	Total
SLR (+)	20	2	22
SLR (-)	5	5	10
Total	25	7	32

The SLR test was found to be more accurate than the slump test in patients with LDH. However, it is the opinion of the authors that this finding pertains more to LDH occurring at the lower levels of the lumbar spine due to the constitution of studied sample.

Discussion

More than a third of the patients tested had severe LDH (bulge and nerve root compression) together with the occurrence of higher frequency of lower LHD (more than 50%). This may explain the outcome where the SLR test is more sensitive. The SLR may apply more tension on the lower levels of the lumbar spine (L4-5 and L5-S1). Other levels of LHD were

underrepresented in the sample.

A systematic review has previously concluded that the accuracy of the SLR test is assumed to be the most appropriate for testing the lower lumbar nerve roots.¹² This was later confirmed by Robin *et al*¹⁵ and our findings corroborate both these authors reports.

However, Majlesi *et al*¹ found the slump test to be more accurate than the SLR, but noted that the SLR was more accurate in patients with protrusions and root compressions while the slump was more accurate in patients with less severe disc herniations. This assertion has recently been reaffirmed by Capra *et al*¹⁸ who recommended after a retrospective study done on 2352 patients to assess the validity of the SLR test for patients with sciatic pain. Their findings indicate that the SLR test may be a useful tool especially in the physical examination of young subjects, where it seems to have a higher diagnostic power for LDH.

The results of this pilot study suggest that the SLR may offer an alternative and time and cost effective procedure to detect LDH. Substantial savings on the cost of MRI investigations and the possibility of an accurate diagnosis of LDH in the absence of MRI enhances the overall quality of care of patients with LDH. This is because, the SLR is a simple physical test procedure with potentially good diagnostic accuracy and can be administered efficiently by an appropriately skilled clinician made more accessible at all levels of the health care system.

Conclusion

The SLR test was more accurate in detecting LDH in patients with LDH at the lower levels of the lumbar spine. Further validation of this finding is recommended by studying a larger sample size, randomizing selection of subjects, and studying a sample in which all levels of LDH are represented.

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